

# Emerging Issues in Carbon Capture and Storage

**Peter J Cook**

**Chief Executive**

**Cooperative Research Centre  
for Greenhouse Gas Technologies**

**(CO2CRC)**

**Australia**

**[www.co2crc.com.au](http://www.co2crc.com.au)**

# Emerging Issues in Carbon Capture and Storage

With thanks to:

Andy Rigg, Barry Hooper, John Bradshaw, Guy Allinson & the GEODISC/CO2CRC Team;

Kelly Thambimuthu & John Gale, IEA;

John Wright, CSIRO;

Jim Dooley & Ken Humphreys, Battelle;

and many others.



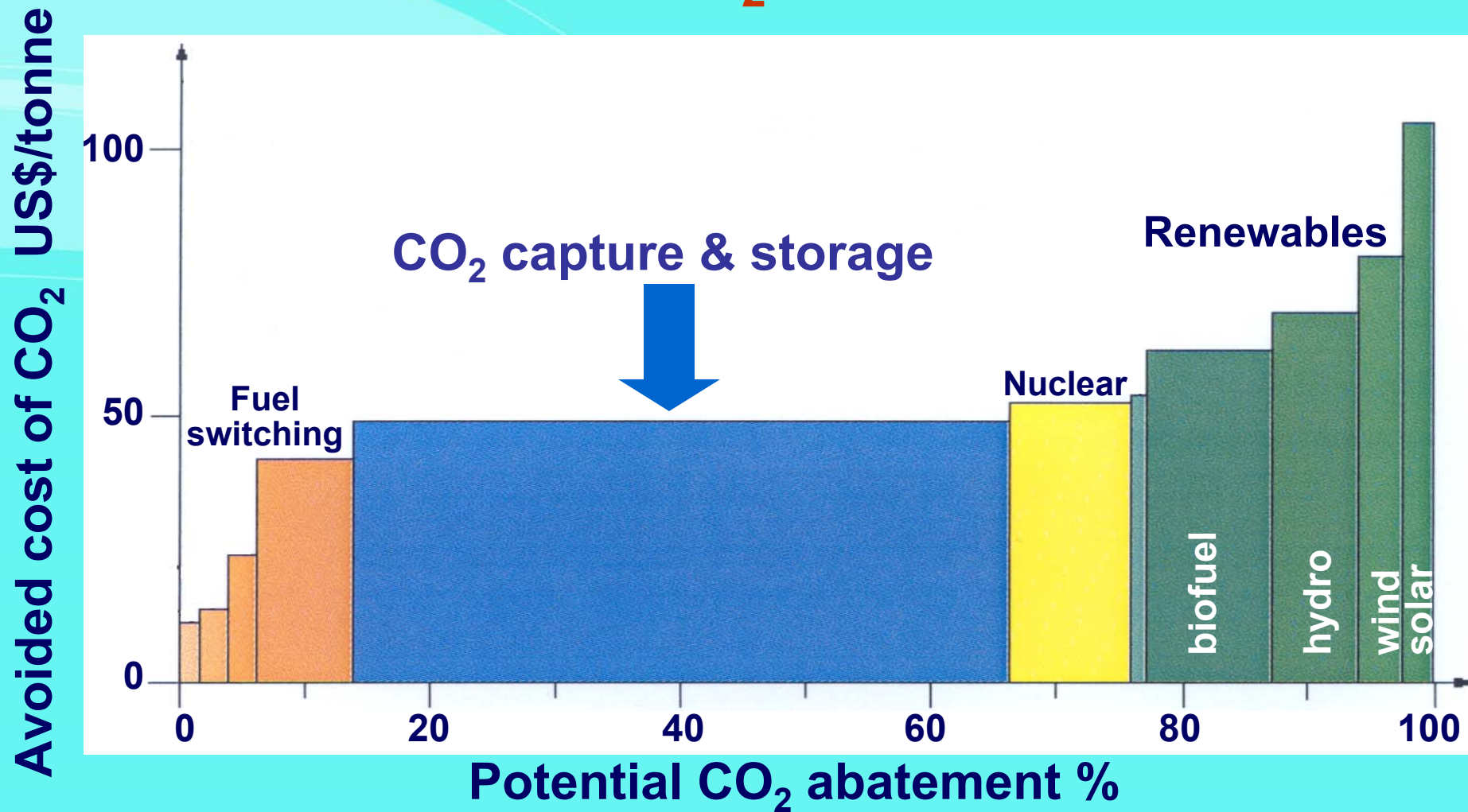
# The Technology Challenge

To decrease current global CO<sub>2</sub> emissions by 10% (1Gt carbon) will require massive technology implementation such as:

- 700 1GW coal fired power plants all with CO<sub>2</sub> sequestration, or
- 3,500 Sleipners, or
- 1500 1GW nuclear power plants

After Socolow, Dooley, Humphreys

# The potential for reduction in EEC generation-based CO<sub>2</sub> emissions



# Emerging Issues in CO<sub>2</sub> Storage

(excluding ocean storage)

## Technical issues

- where can we store?
- how much can we store?
- at what cost?
- with what degree of confidence?
- for how long?

## Community issues

- is it safe?
- is it ethical?
- is there a better way?

# Emerging Issues in CO<sub>2</sub> Capture

## Technical issues

- how?
- at what cost and what efficiency?
- what to do about contaminants?
- regional hubs?

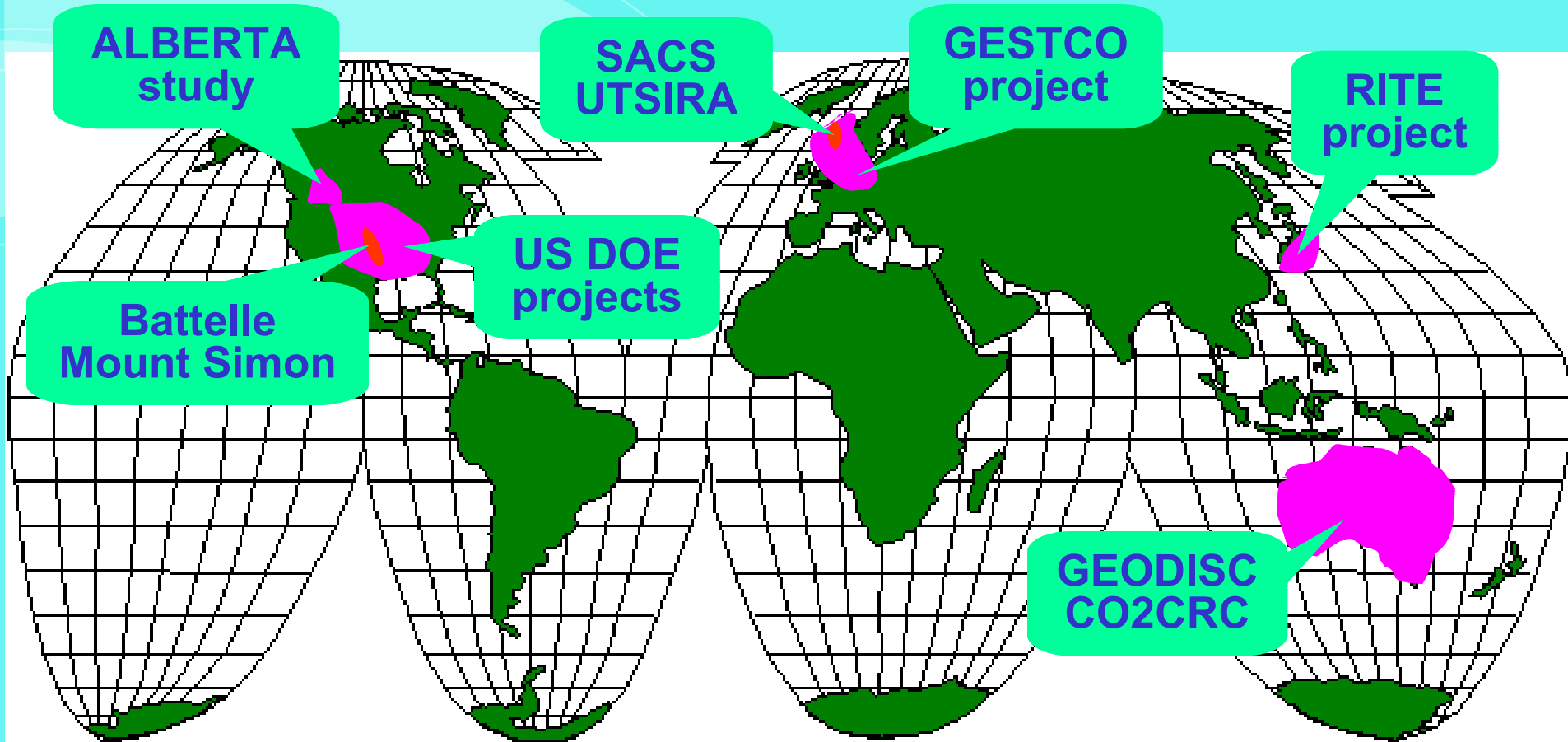
## Community issues

- will higher power costs be acceptable
- will 'do nothing' be acceptable?

# CO<sub>2</sub> Storage – how and where?

- Geological storage potential is enormous, but we need to turn that potential into useable storage capacity
- Range of opportunities need consideration
  - basalt, mineral, building materials (minor)
  - deep coals, enhanced petroleum recovery
  - modest economic benefit, limited volume
- Saline aquifers the most potential by far, but
  - few regional or national studies
  - limited offshore (subsea) assessment.
  - limited matching of CO<sub>2</sub> sources and sinks

# Research on mapping aquifers

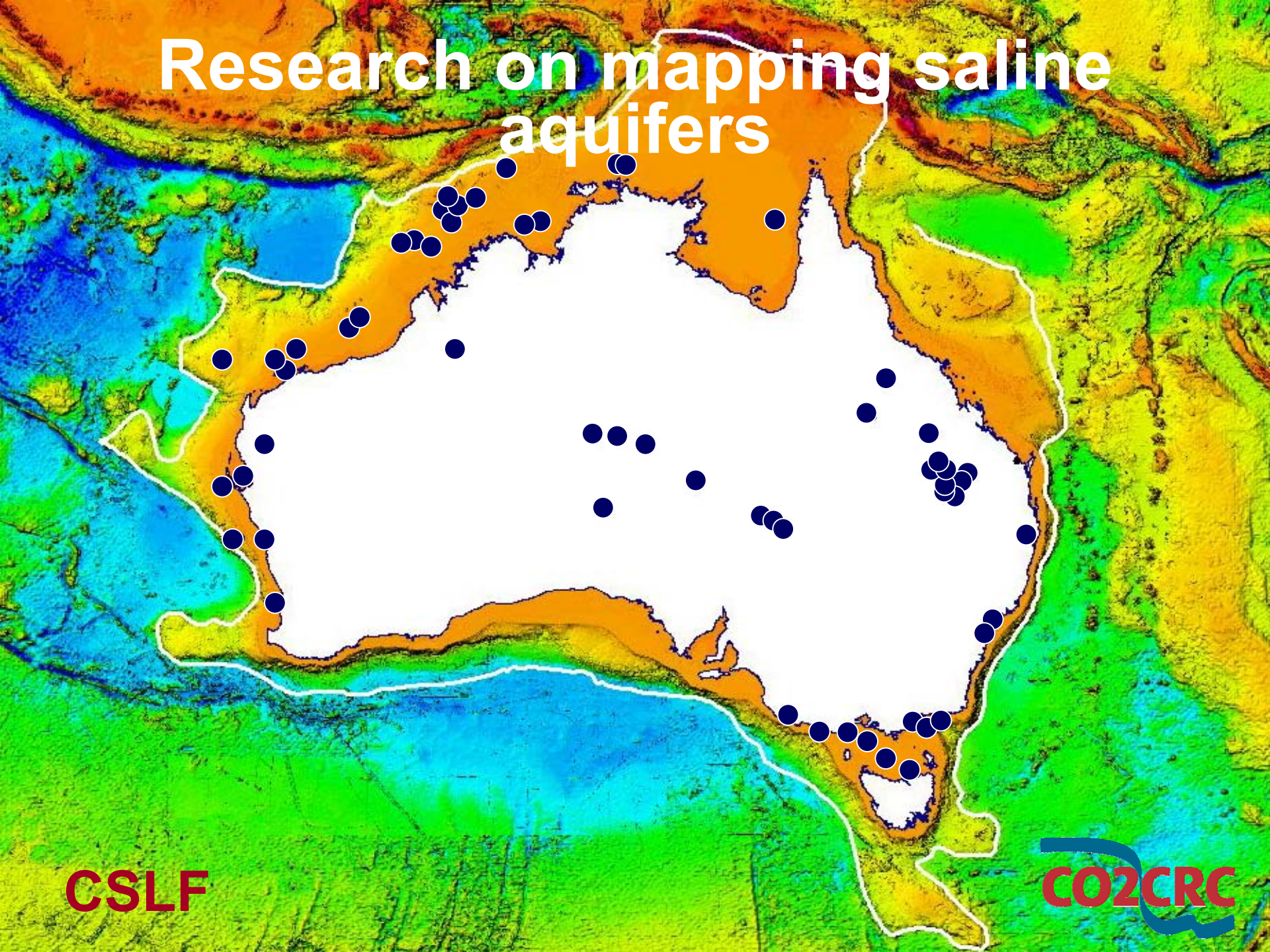


CSLF

After Gale

CO2CRC

# Research on mapping saline aquifers

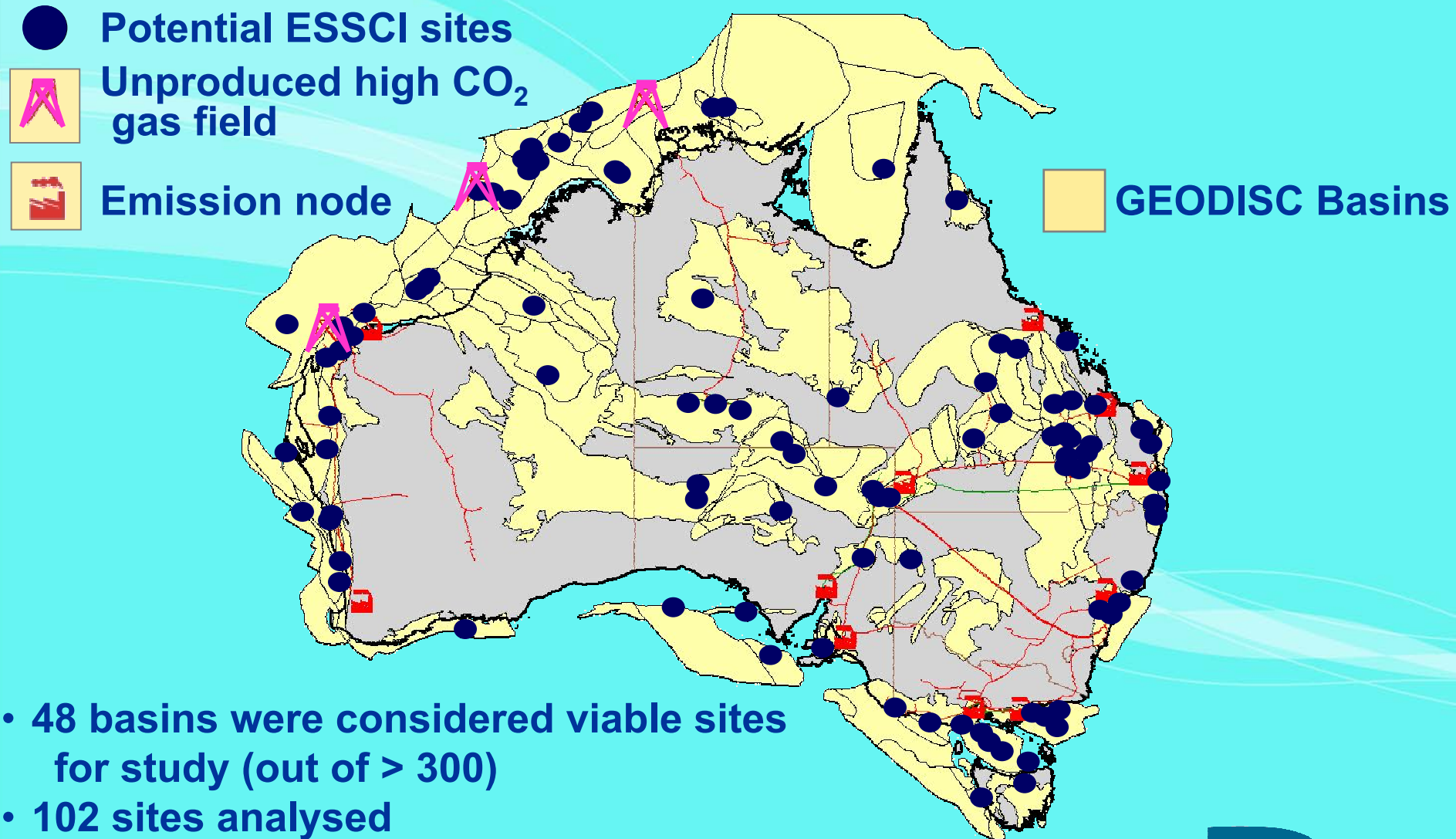


CSLF

CO2CRC

# CO<sub>2</sub> Source-Sink Studies

( after Bradshaw et al)



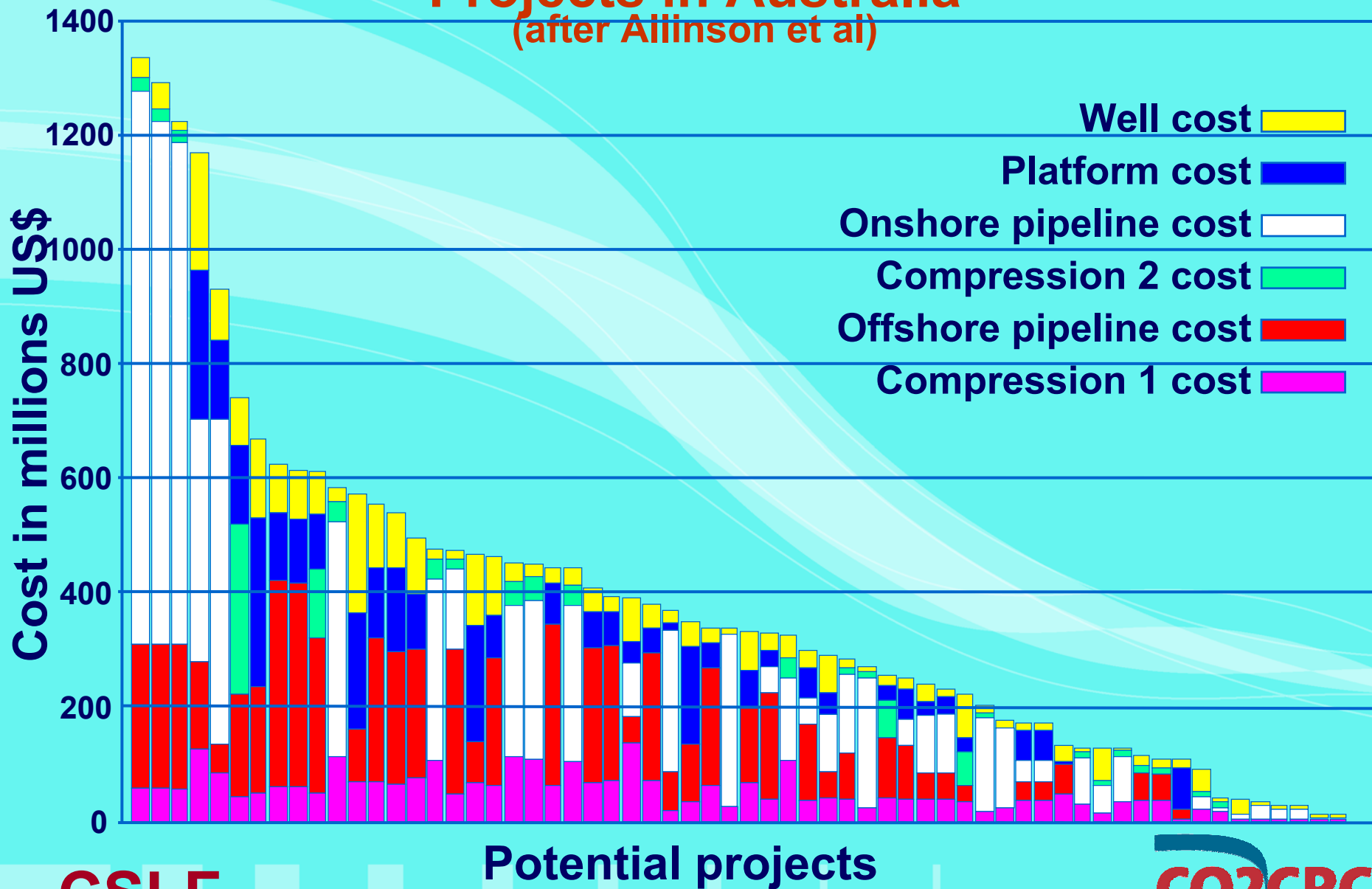
- 48 basins were considered viable sites for study (out of > 300)
- 102 sites analysed
- 65 proved viable ESSCIs
- 22 sites not viable; 15 regional basin overviews

# CO<sub>2</sub> Storage – at what cost?

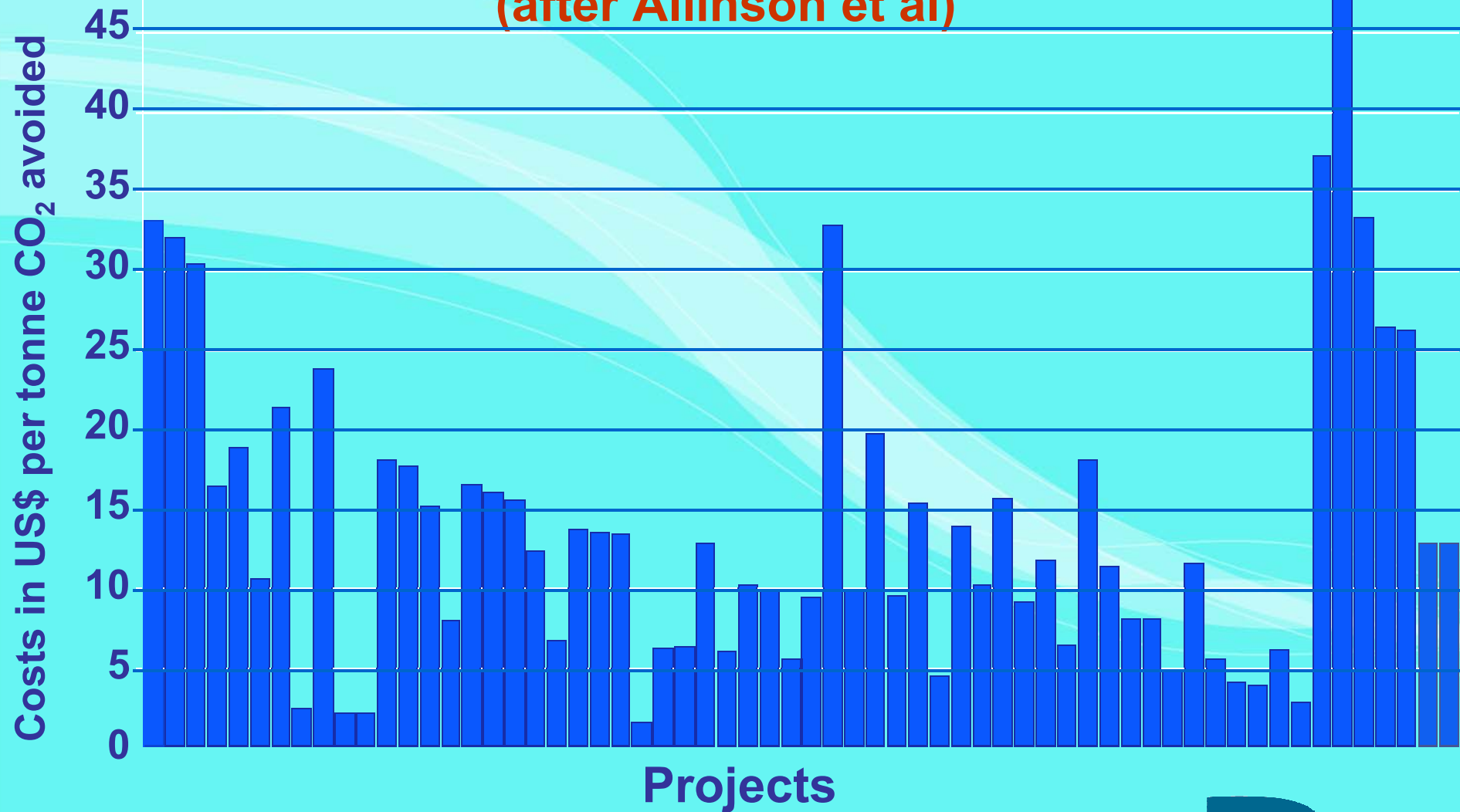
- Need more high level economic modelling that incorporates future technology
- Scope for bringing costs down, but
  - monitoring & verification could increase costs somewhat
- Some generic costings by TNO, IEA
  - results encouraging
- Project costings by GEODISC/CO2CRC
  - results project specific, but encouraging and informative

# Capital Costs for Some Potential CO<sub>2</sub> Storage Projects in Australia

(after Allinson et al)



# 'Break even' carbon credit for potential Australian CO<sub>2</sub> source-sink projects (after Allinson et al)

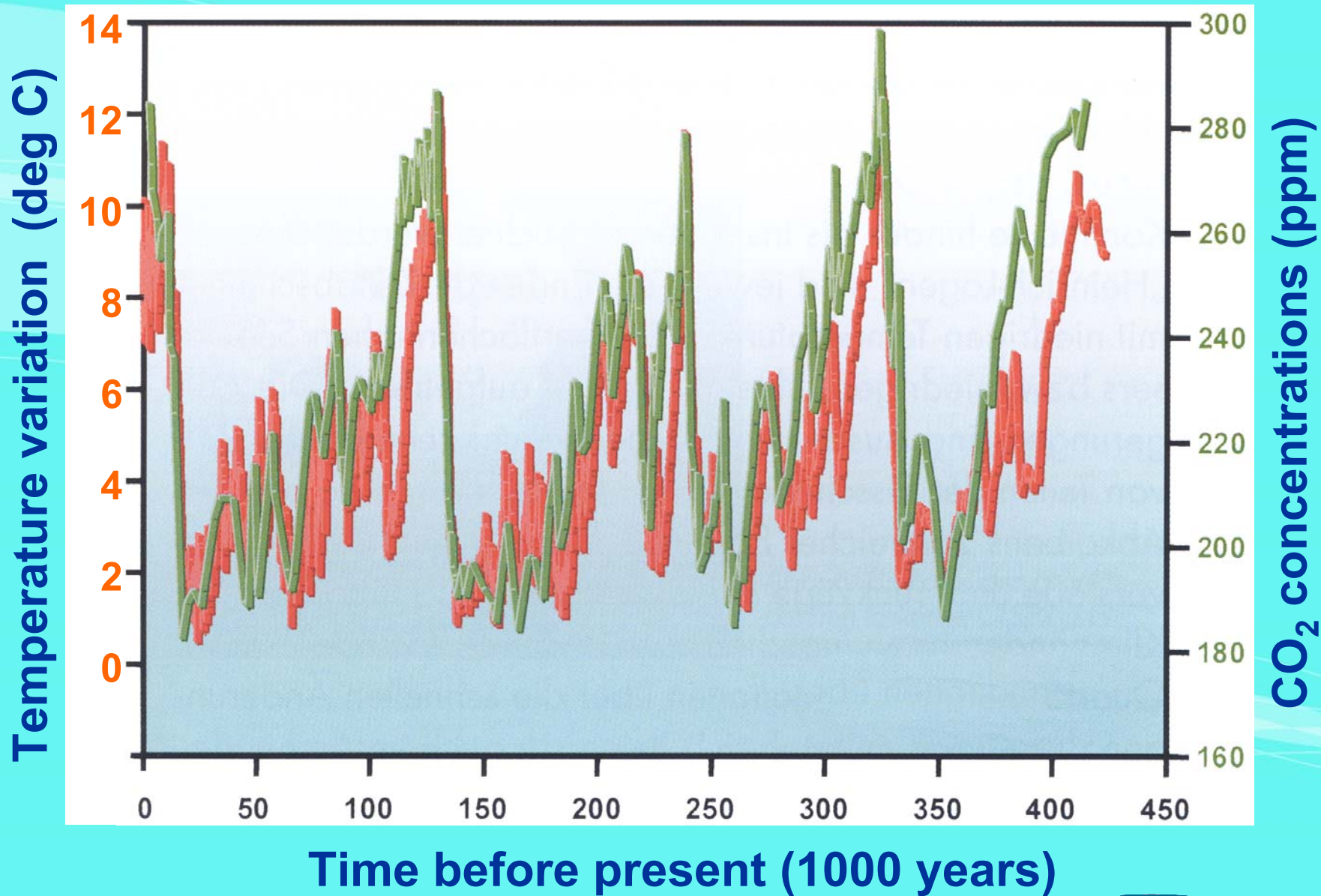


CSLF



# CO<sub>2</sub> Storage –how effective?

- Modern analogues especially important
  - major area for international collaboration
- With what degree of confidence
  - modelling?
  - monitoring?
  - any leakage?
- For hundreds, or thousands, or millions of years?
  - or for ever?



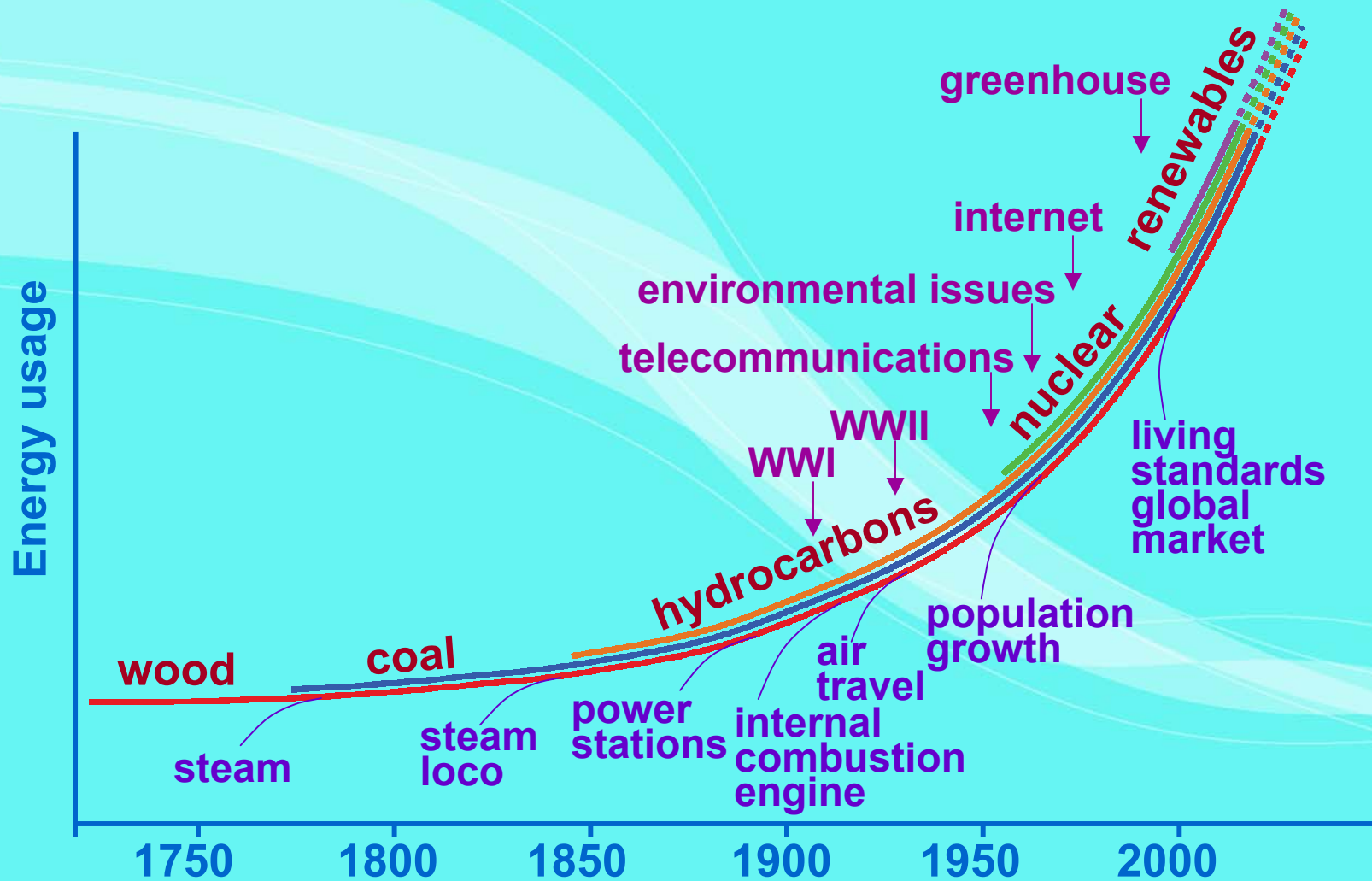
CSLF

Vostok Icecores – Antarctica  
Berner & Streif (2001)

CO2CRC

# Energy usage

‘modifiers’ above the curve and ‘drivers’ below the curve



# CO<sub>2</sub> Storage – with what degree of confidence?

- Monitoring & verification are a key part of risk assessment
  - but no agreed protocols as yet
- Need international collaboration and agreed methodologies for monitoring, verification & risking
- Critical risk issues relate to
  - containment (duration; risk of leakage)
  - effectiveness (reach full potential?)
  - stakeholder response



WHEN SHELL LOOKED TO  
**REDUCE CO<sub>2</sub>**  
**EMISSIONS,**  
A SOLUTION WAS RIGHT  
UNDER OUR FEET.

As part of our commitment to sustainable development, Shell is sponsoring a major new greenhouse gas reduction initiative called 'CO<sub>2</sub>CRC'.

The initiative is studying the geological sequestration, or permanent storage, of fossil fuel emissions in permeable sandstone formations within the earth's subsurface.

Australia is well placed to make use of geological storage of carbon dioxide and our research will ensure that CO<sub>2</sub> can

be safely and effectively disposed of in the deep subsurface.

So rather than releasing it into the atmosphere where it would contribute to the build up of greenhouse gases,

we'll essentially be putting CO<sub>2</sub> back where it came from.

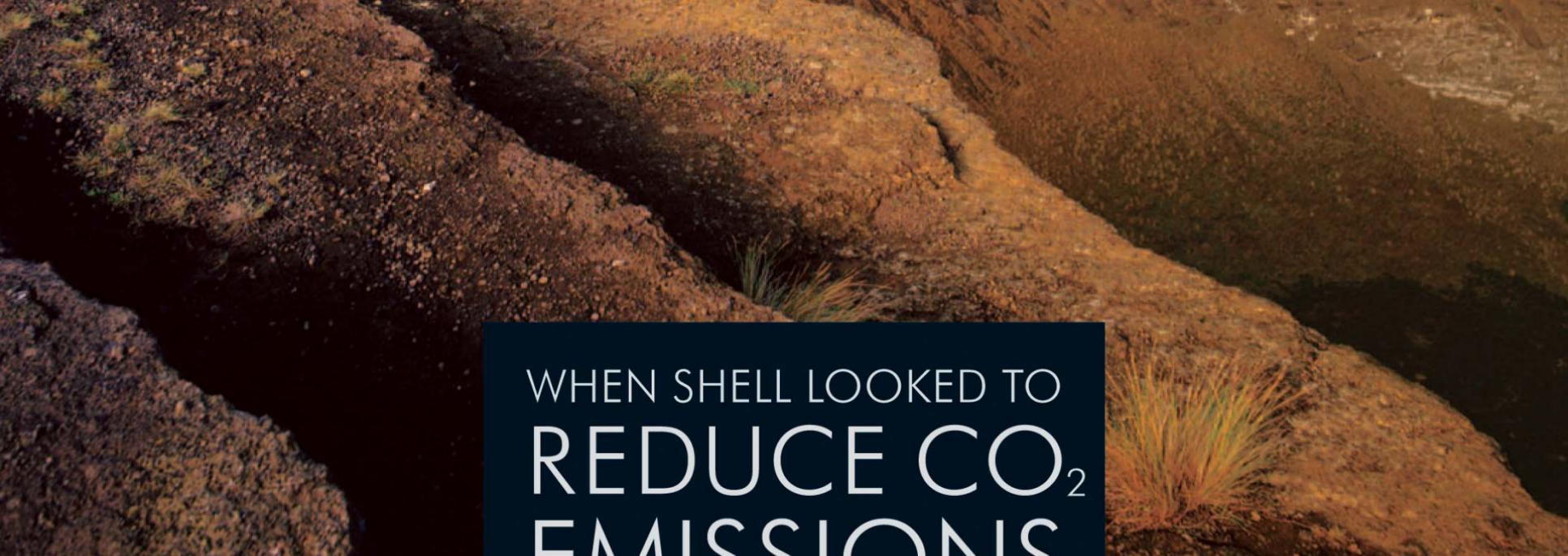
For more information on this and Shell's other sustainable development activities, visit [www.shell.com.au/listenresponding](http://www.shell.com.au/listenresponding)

**CSLF**



SH1122

**CO<sub>2</sub>CRC**



WHEN SHELL LOOKED TO  
**REDUCE CO<sub>2</sub>  
EMISSIONS,**  
A SOLUTION WAS RIGHT  
UNDER OUR FEET.

As part of our commitment to sustainable development, Shell is sponsoring a major new greenhouse gas reduction initiative called 'CO2CRC'.

The initiative is studying the geological sequestration, or permanent storage, of fossil fuel emissions in permeable sandstone formations within the earth's subsurface.

Australia is well placed to make use of geological storage of carbon dioxide and our research will ensure that CO2 can

be safely and effectively disposed of in the deep subsurface.

So rather than releasing it into the atmosphere where it would contribute to the build up of greenhouse gases,

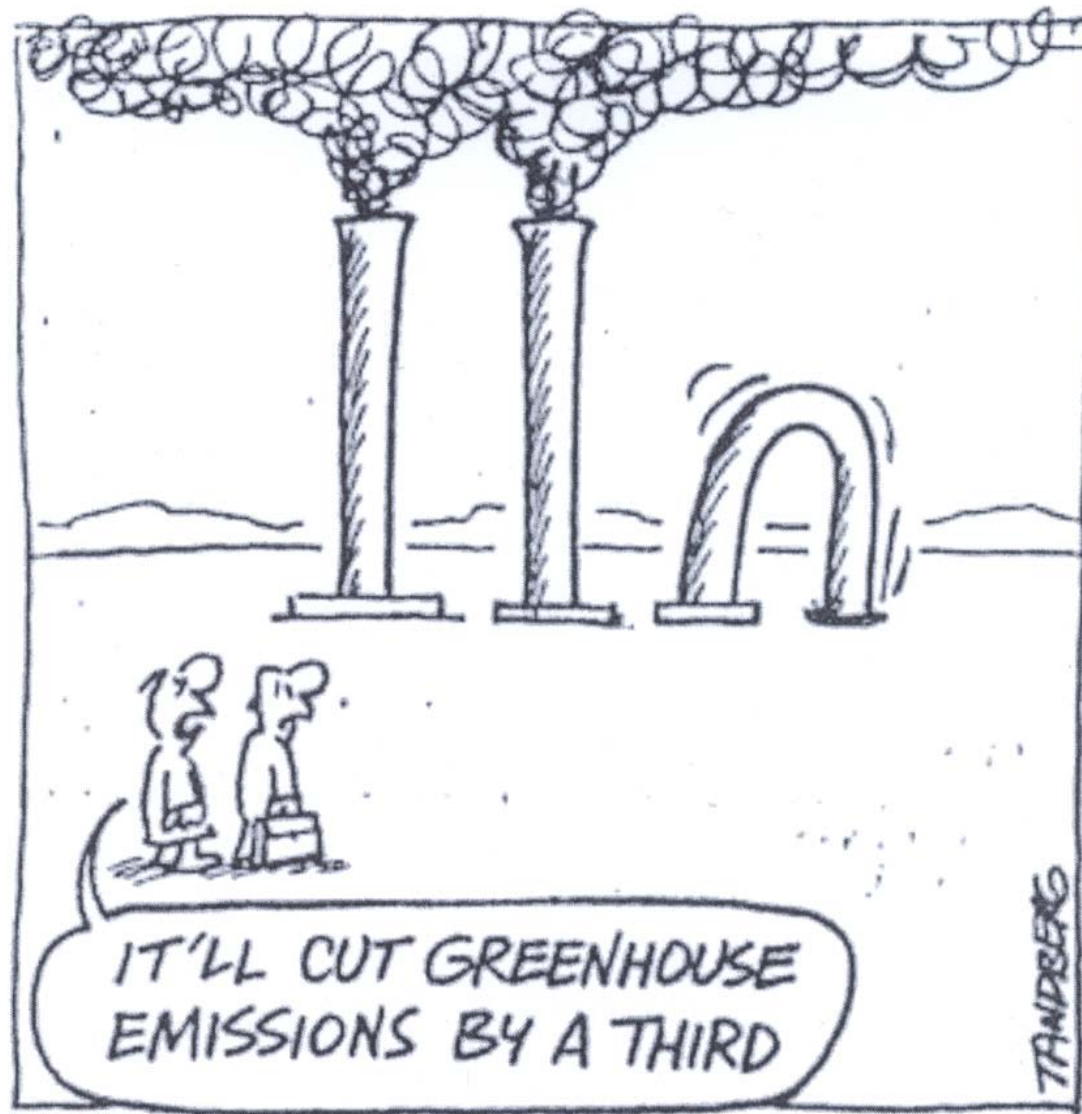
we'll essentially be putting CO2 back where it came from.

For more information on this and Shell's other sustainable development activities, visit [www.shell.com.au/listenresponding](http://www.shell.com.au/listenresponding)



# CO<sub>2</sub> Storage – community issues – safe, sustainable, ethical?

- Major projects will demonstrate
  - technical competence
  - capacity to effectively model, monitor & verify
  - safety
  - sustainability
- Ethical considerations focus on
  - environmental impact on communities/ flora/fauna including 'deep fauna'
  - Ongoing use of fossil fuels
- Communication, education and listening will be requisites for the scientific community



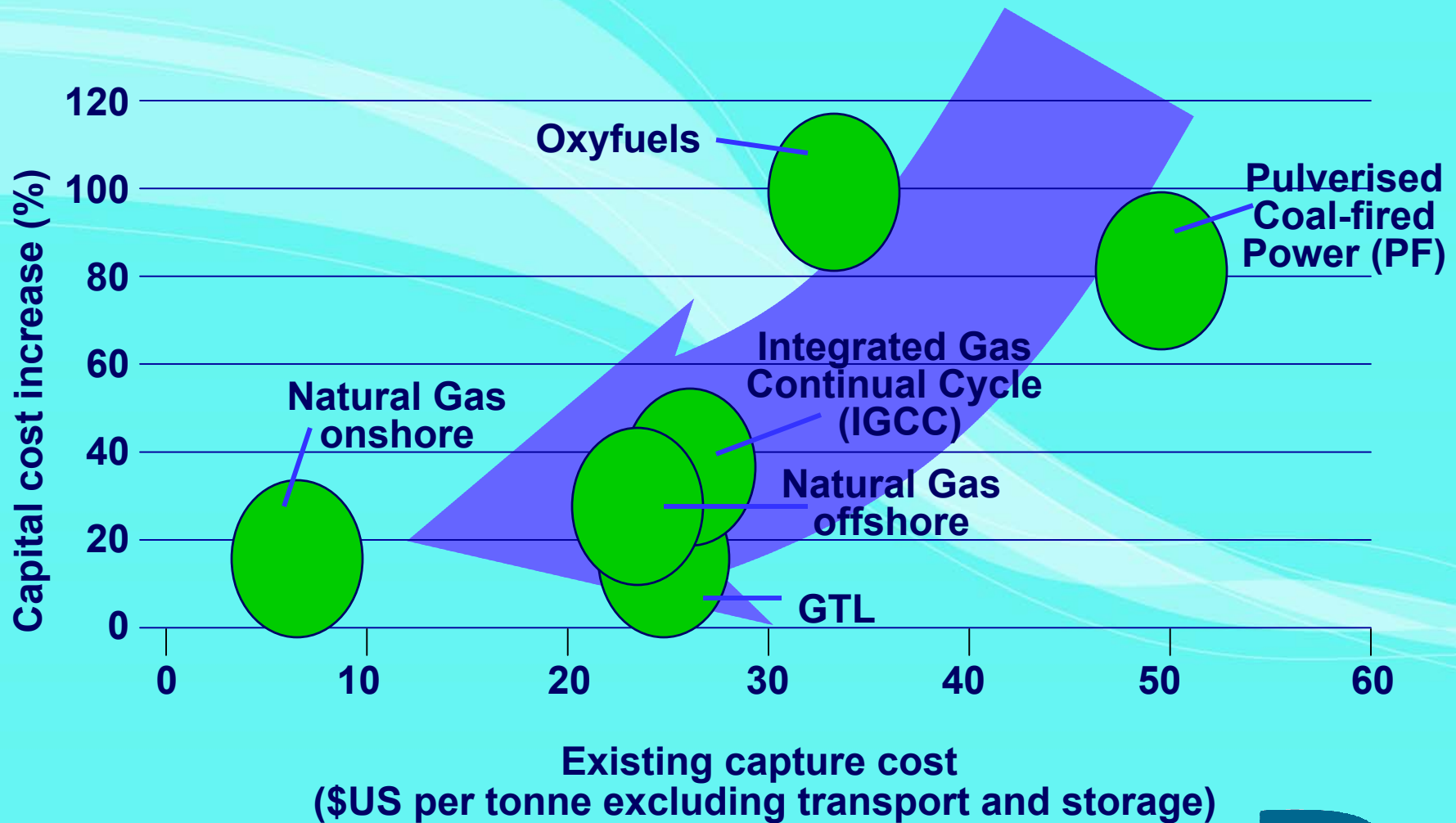
# CO<sub>2</sub> Capture – how?

- Capture options
  - Solvents
  - Membranes
  - Adsorption (PSA, ESA)
  - Cryogenic
  - Capture in fuel cells } and hybrids
- But how much effort should be directed at PF power generation involving retrofit?
- compared to implementing
  - IGCC
  - Oxyfuels
  - other advanced energy production systems?

# CO<sub>2</sub> Capture – bringing down costs & improving energy efficiency?

- Engagement of power industry is critical
- Incremental change will help but too slow
- Step change is needed
  - this will be challenging and require a major international research effort
  - and perhaps specific economic drivers

# Cost of Implementing CO<sub>2</sub> Capture



# CO<sub>2</sub> Capture – dealing with contaminants?

- Only some countries remove contaminants
- Many contaminants will ‘poison’ capture systems
- Should we consider the option of storage of gas mixtures (CO<sub>2</sub> + H<sub>2</sub>S/NO<sub>x</sub>/SO<sub>x</sub> etc)
  - some already underway
  - problem of community acceptance?

# Weyburn EOR – CO<sub>2</sub> Storage Project

Farmhouse



CO<sub>2</sub>  
Injection  
site



Production  
well

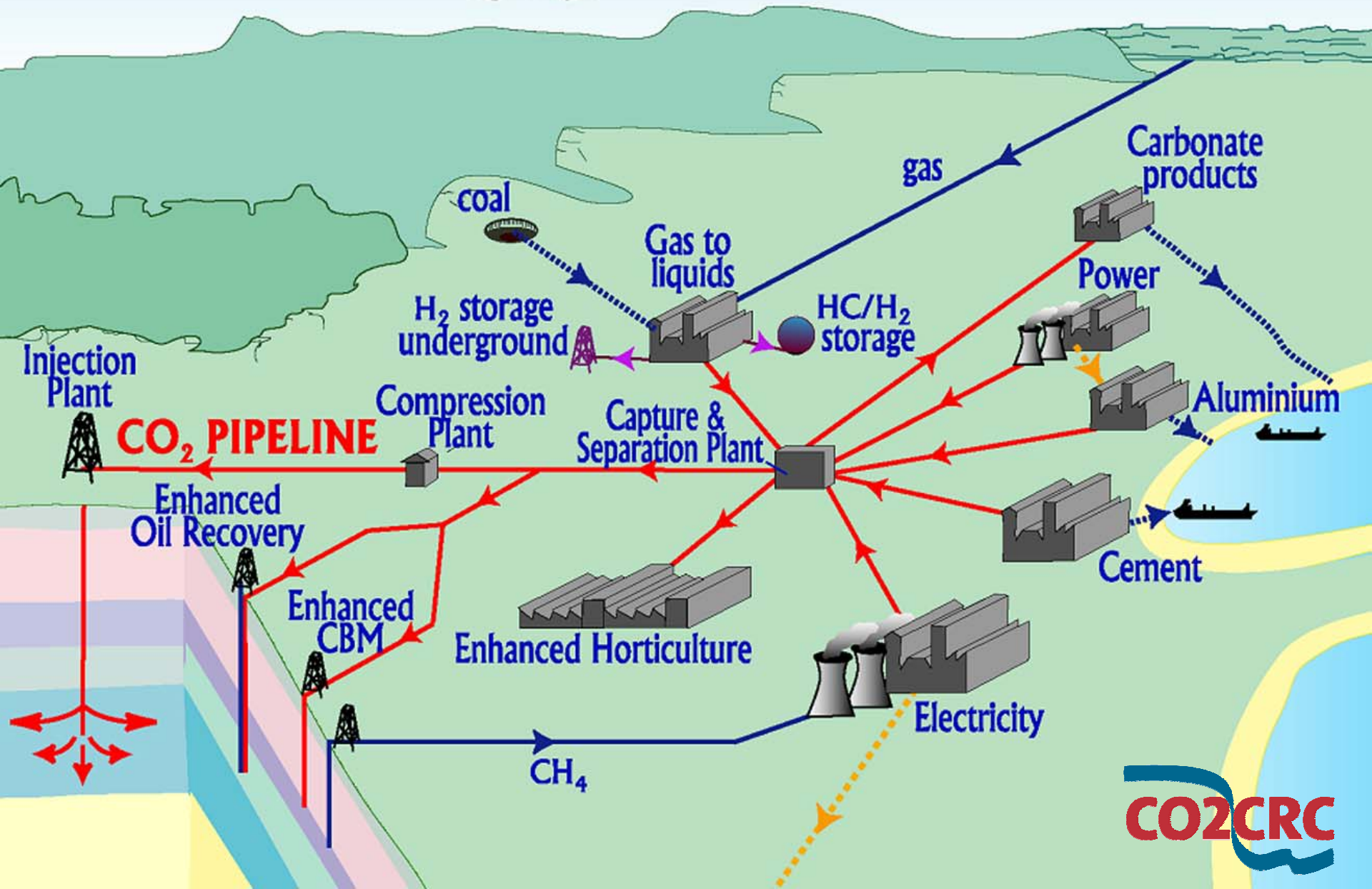
CSLF

CO<sub>2</sub>CRC

# CO<sub>2</sub> Capture – regional hubs and bringing down costs?

- Capture and storage costs will be high on a 'single emitter' basis
- A 'multiple emitter' hub and the concept of an 'industrial ecosystem' may be a better long term option
  - and is likely to receive regional (and political) support

# “an emission free vision”

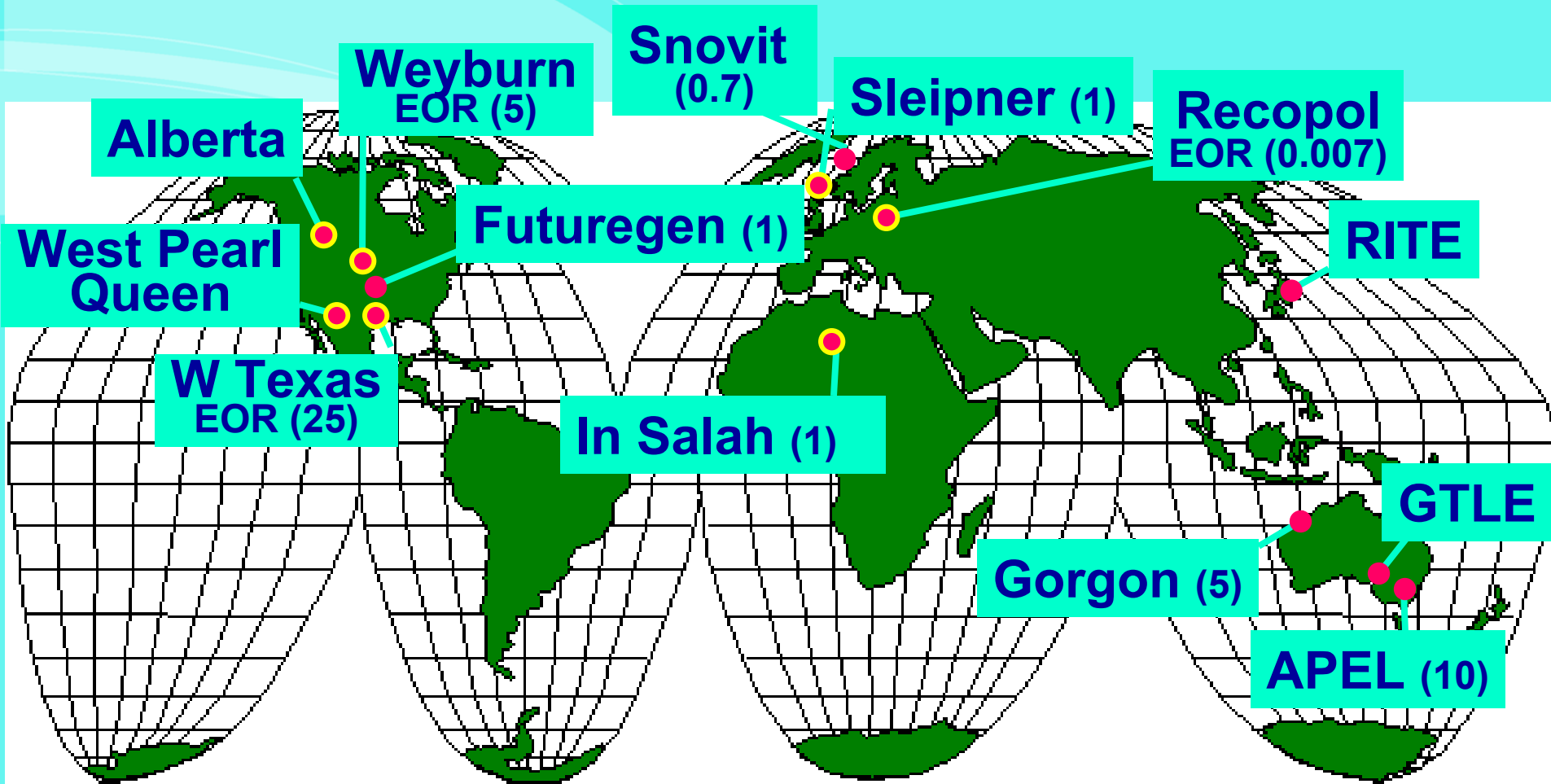


# **Realising the full potential of carbon sequestration technologies**

**will require**

- Enhanced R&D and international collaboration**
- Engaging developing countries**
- Training and technology transfer**
- Improved capture and storage economics**
- Assess storage potential onshore and offshore**
- Protocols for monitoring, verification, risking**
- Community acceptance**
- Major 'demonstration' projects**

# Current & Proposed CO<sub>2</sub> Storage Sites



(1) CO<sub>2</sub> storage Mt per year

● underway  
● proposed

CSLF

CO<sub>2</sub>CRC

**There will be differing national and regional priorities , but it is only by collective international action that we will be able to undertake essential R&D, achieve necessary technology breakthroughs, and implement new carbon sequestration technologies on the massive scale required to significantly decrease global CO<sub>2</sub> emissions to the atmosphere.**



**CSLF**

